CEREC Zeitung

No.17 – **2010** International edition

Nature as a model

The new biogeneric software produces individual occlusional surfaces. **PAGE 2**

Perfect partners

CEREC Connect helps dentists and dental technicians to collaborate. **PAGE 4**

Precise implant therapy

The integration of GALILEOS and CEREC streamlines the dentist's workflow. **PAGE 5**

EDITORIAL

Birgit Möller, Marketing Director Dental CAD/CAM Systems at Sirona.

A generation that changed the world!

Do you remember the old PC 10 from Commodore and its floppy disk drive? 25 years have passed since this "IBM compatible" PC was launched. In the meantime we've seen a revolution in computer technology. Bill Gates moved from his garage to conquer the market with Microsoft. Steve Jobs made his fortune by selling apples. Back then only companies could command the kind of capacities that are nowadays used by kids. Technological progress took us by storm. As the processors got smaller, capacities just got bigger. As the technology became increasingly complex, the applications just got easier to use. CEREC has taken the same course in dentistry. Starting in 1985, the CEREC 1 had a black monitor with green characters. Users had to function as quasi-programmers in order to model the inlay. But the results were so encouraging that the developers were convinced they were on to something big. Thanks to the progress made in IT and the input of our partners in terms of hardware, software and materials, the CEREC method has since been developed to a high level of sophistication. At the CEREC World Congress our users demonstrated the opportunities the CEREC system offers. Join me in looking forward to the next 25 years of CEREC.

Yours truly,
Birgit Möller

CEREC Zeitung

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The Dental Company

US dentists say: Yes, we scan!

25 YEARS OF CEREC. An international symposium in Las Vegas celebrated the 25th birthday of the world's most successful CAD/CAM restoration system. The attendees acquired new perspectives on state-of-the-art dental treatment.

CEREC is a resounding success story. So far approx. 26 million all-ceramic restorations have been designed and milled using this advanced CAD/CAM system. Contemporaries will have only vague memories of the year 1985, when the world's first ever computer-designed and milled ceramic inlay was created at Zurich University.

In the meantime we have become accustomed to the fact that digital technology streamlines treatment procedures and paves the way to long-lasting clinical results. For a long time CEREC was the only dental restoration system on the market which exploited the benefits of optoelectronic impressions. Today CEREC is the most widely used dental CAD/CAM procedure for all-ceramic restorations. Only CEREC can look back on 25 years of clinical experience. The birthday celebration at the end of August took place against the backdrop of an international symposium in Las Vegas, which attracted around 3,000 attendees. The symposium examined the past, and looked ahead to the future. Forty speakers reported on new developments which will speed up treatment procedures and laboratory processes and facilitate close networking with external systems.

Professor Fasbinder pointed out that CEREC restorations have demonstrated their longevity in numerous clinical trials. The so-called "gold standard" is no longer exclusively reserved for metal-based restorations. Professor Mörmann emphasized that CEREC has not stood still. On the contrary, the system now forms the nucleus for networked applications – for example, "impression-free" treatment and integrated digital radiography.

Even after 25 years the enthusiasm of the CEREC community is clearly evident.

Professor Mehl focused on biogeneric occlusal surface design. This was augmented by practical reports given by the US dental practitioners Klim, Park and Puri, who confirmed that the biogeneric software is a highly effective tool for fabricating crowns. The dentist Skramstad and the dental technicians Nieting and Sikes described the possibilities for exchanging virtual models via the CEREC Connect web portal. This portal is used by the Glidewell Laboratory, which has 2,600 employees on its payroll. To an increasing extent Glidewell is receiving online orders for crowns and bridges from dental practices within the CEREC Connect network. The dentists Agarwal, Bindl, Kusama, Reznick and Patel talked about the possibilities for importing CEREC scans into CBCT images (GALILEOS). This enhances the precision of the implant planning process and minimizes the risks of implant therapy.

Thanks to CEREC, aesthetic restorations are now available at various price levels. The speakers in Las Vegas described how monolithic feldspar and lithium disilicate crowns can be polished, glazed, characterized or veneered using the cutback method. These techniques serve two goals: to fulfil individual aesthetic requirements, and to adapt to the patient's individual financial resources. CEREC has become rapidly established in the USA, a market which is traditionally quick to adopt new advances in medical technology. "Yes, we scan," concluded Gordon Christensen (CRA Newsletter) and predicted dynamic future growth for CEREC. This CAD/CAM system fulfills the increasing demands in terms of productivity, flexibility and cost-effectiveness. Las Vegas clearly demonstrated that CEREC has the potential to continue setting the standard in dental CAD/CAM technology. ■

Speakers at the CEREC 25 symposium pictured in front of Caesars Palace, Las Vegas (from left to right): Puri (USA), Roessler (Australia), Reiss (Germany), Hyman (USA), Morin (USA), Mörmann (Switzerland). Moderator: Manji (USA).

Las Vegas provided the perfect setting for a productive get-together with dental colleagues.

NEWS

Master's program for Clinical Dental CAD/CAM

The master's degree program "Clinical Dental CAD/CAM" covers all the latest developments in computerized dentistry. It was launched at Greifswald University in May 2010, with an initial enrolment of 14 students. Developed in collaboration with the German Society for Computerized Dentistry (DGCZ), the course consists of 13 modules plus a master's thesis. Graduates will be awarded a Master of Science degree (M.Sc.) by Greifswald University.

The first two introductory modules took place in Greifswald. Further modules will take place at various locations in Germany and Switzerland. The line-up of lecturers includes Prof. Benz and Prof. Edelhoff in Munich, Prof. Mehl and PD Dr. Bindl in Zurich, Prof. Frankenberger in Marburg, Dr. Baltzer and Dental Technician Jinoian in Liestal (Switzerland), Prof. Luthardt in Ulm, Dentist P. Neumann in Berlin, PD Dr. Reich in Aachen, Dr. Reiss in Malsch, Dr. Wiedhahn in Hamburg, and Prof. Kordaß in Greifswald.

The next commencement date for the Master's Program is May 2011.

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Occlusal surfaces based on natural principles

BIOGENERIC. No two teeth are identical. The new automatic biogeneric software produces individual occlusal surface designs for crowns and bridges. These possibilities have convinced Sameer Puri, DDS.

The "architecture" of occlusal surfaces is not a random coincidence, but the product of a genetic "blueprint". Like human fingerprints no two occlusal surfaces are identical. The occlusal surfaces are a key factor in functional occlusion. Within the framework of a prosthetic rehabilitation the reconstruction of the occlusal surfaces requires extensive experience on the part of the dentist. The biogeneric design function realized in version 3.80 of the CEREC software is capable of reproducing natural and functional occlusal surfaces for each patient individually. This applies to inlays, onlays, partial crowns and crowns.

Introduced in 2008, the first version of the biogeneric model successfully reconstructed the occlusal surfaces of inlays, onlays and partial crowns – albeit on the basis of residual tooth detection. The next step was to realize automatic, patient-specific occlusal surface design for crowns and bridges – also with the aid of the inLab system for dental laboratories. On the assumption that each tooth must display a particular morphology in order to ensure a harmonious chewing function, mathematical methods were used in order to decode the genetically determined laws.

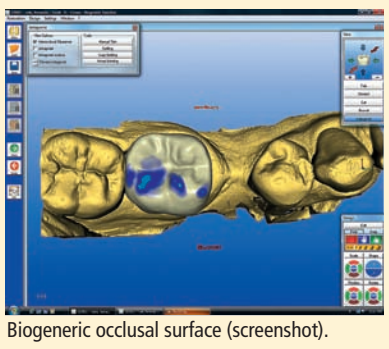
In principle, it is possible to deduce the morphology of a missing tooth from any intact posterior tooth in the patient's mouth. However, the greater the distance between the reference tooth and the restoration, then the smaller the degree of correlation. The decisive question is whether the biogeneric identifies the reference tooth as typical and then generates a suitable design proposal. This enhances the reliability of the reconstruction proposal and at the same time facilitates a high degree of automation.

Sameer Puri, DDS, runs a private practice in Narzana, CA, near Los Angeles. The certified CEREC Trainer also runs the blog "CEREC-Doctors".

Biogeneric occlusal surfaces – better than those derived from dental databases

The automatic biogeneric software experience is based on approx. 30 crown restorations. The crown stump and the adjacent reference tooth are optically scanned. Following this optical scans are acquired of the antagonist, as well as the tooth stump in terminal occlusion. The preparation margin is marked with just a few mouse clicks. This is followed by the computation of a matching crown. To this end the correspondence analysis function identifies the typical characteristics of the reference tooth and then generates a patient-specific occlusal surface for the crown restoration. The restoration proposal and the occlusal functions can be evaluated visually in all three dimensions. The user still has the possibility to make minor adjustments – for example, to the contact points and the height of the marginal ridge. The biogeneric software automatically generates patient-specific, functionally designed restorations in almost all clinical situations. They are more natural and display superior functional properties in comparison with those derived from dental databases and they require virtually no milling-in. Any premature contacts can be removed during the polishing process when the restoration is finally placed. I value the significant reduction in treatment time. The biogeneric production of occlusal surfaces are like a tailor-made suit that fits perfectly. ■

Prepared crown stump.



Biogeneric occlusal surface (screenshot).

Crown occlusal surface in situ.

A Quantum Leap for dentistry

A STORY OF SUCCESS. CAD/CAM techniques have changed dentistry. Prof. Mörmann tells us more about the development of the CEREC system.

It is hard to envisage dentistry without modern CAD/CAM techniques. Digital impression-taking, the scanning of antagonists and bite registers, 3D design on the monitor, the computation of patient-specific occlusal surfaces, virtual models composed of multiple scan images, the subtractive machining of high-performance ceramics – all this would be impossible without computers. This quantum leap was unleashed by Professor Werner Mörmann and Dr.-Ing. Marco Brandestini at Zurich University in 1985. The CEREC system established the chairside method for single-visit ceramic restorations – a procedure which has taken root in almost all industrialized nations and now numbers among the most intensively researched dental therapy procedures.

The impetus for the development of this CAD/CAM system came from two sources. Firstly, the proponents of computer-aided chairside restorations wanted to machine industrially manufactured silicate ceramics with defined physical characteristics directly adjacent to the chair and treat the patient during a single visit, without the need for a temporary (i.e. eliminating the risk of damage to the cavity margins). The second factor was the introduction of adhesive bonding, which creates a force-locked union between the ceramic restoration and the residual tooth tissue. It does not have a mechanical interface and hence prevents crack-inducing tensile stress. Since then it has been possible to apply defect-oriented and substance-conserving preparation techniques. It was possible to dispense with mechanical retention in the cavity geometry, due to the fact that adhesive bonding guarantees an intimate link with the residual tooth. A second, subsequent idea was to make use of high-strength oxide ceramics – for example, aluminium oxide (Al_2O_3) and zirconium oxide (ZrO_2) – and computer-controlled milling machines in order to create crown and bridge frameworks.

Initial concerns about the marginal fit proved to be unfounded. In contrast to cast fillings, adhesively bonded CEREC restorations are not subject to the same preparation guidelines as metal restorations. Instead, their durability derives from the intimate adhesive bond between the ceramic restoration and the enamel/dentine of the residual tooth – and from the fact that the restoration can be placed immediately. Evidence is the large number of restorations that are still intact after a service life of 20 years.

Prof. em. Dr. Werner H. Mörmann
former Director of the Department of Computerized Restorations at Zurich University.

Three-dimensional visualization for precise diagnosis

A further quantum leap was CEREC 3D, which supported the three-dimensional visualization of the clinical situation and the design process on the monitor. This allows the user to evaluate the architecture of the preparation and the anatomical details of the restoration proposal – also with reference to the antagonists. The CEREC AC acquisition centre is equipped with the new CEREC Bluecam camera. The short-wavelength blue light emitted by this camera has significantly increased the accuracy of measurement. As a result the impression-free dental practice has become a practical reality. The CEREC Connect* web portal has fostered the closer integration of dental practices and dental laboratories. Intraoral CEREC impressions and extraoral inLab scans can be now be combined to form a quadrant model. The model data is then transmitted to a dental laboratory via the Internet. CEREC Connect simplifies communication between the dentist and the dental technician.

The next milestone was the biogeneric design function for crowns. This entailed the algorithmic analysis of naturally occurring morphologies and the creation of patient-specific occlusal surfaces. Dental databases have been rendered superfluous. It is no longer necessary to mill-in the restorations. The integration of CEREC and cone beam computer tomography (GALILEOS) allows dentists to achieve significantly higher levels of precision and safety when planning and placing implants. The three-dimensional CBCT images not only facilitate the accurate diagnosis of the bone and soft tissue, but also enable the exact positioning and angulation of the endosseous posts, as well as the design of surgical guides. In addition, it is possible to integrate intraoral scans acquired on the CEREC AC unit into the CBCT image. This allows the dentist to superimpose the planned abutment and implant crown on top of the implant and hence evaluate the feasibility of the prosthetic superstructure. The dentist can evaluate the fit of the endosseous post and superstructure before he begins the surgical intervention. "CEREC meets GALILEOS" has created the basis for a prosthetics-oriented implant planning technique which virtually rules out subsequent complications.

**CEREC Connect is not available in all countries.*

Photos: Puri.

25 years of proven clinical performance

LONGEVITY. CEREC is one of the most intensively researched dental systems. Convincing results marked important milestones on the way to become a standard of dentistry, says Dr. Dennis Fasbinder, University of Michigan.

In 1985 Professor Mörmann, Dr.-Ing. Brandestini and their team laid down the foundations for a new treatment system consisting of optical impression-taking, computer-aided design and numerically controlled milling. This new concept motivated large numbers of clinicians and prompted them to carry-out their own follow-up investigations. Today, CEREC is one of the most closely scrutinized dental procedures – a fact reflected in more than 250 clinical studies and approx. 6,500 longitudinally monitored restorations. Long-term observations indicate that adhesively bonded restorations fabricated on the first versions of the CEREC system (CEREC 1 and 2) achieve higher survival probability rates (according to Kaplan-Meier) than conventional layered ceramic restorations. CEREC restorations with service times in excess of 20 years still display a degree of clinical excellence which is normally attributed to metal-based restorations. On the basis of this extensive long-term experience there are convincing reasons for recommending CEREC-fabricated inlays, onlays, partial crowns, veneers, anterior crowns and posterior crowns as an alternative to conventional metal-based restorations.

Dr. Dennis Fasbinder, DDS, is Clinical Professor in the Department of Cariology, Restorative Sciences and Endodontics, at the University of Michigan.

Immediate treatment stabilizes the enamel

The goal was to deploy CAD/CAM technology to create immediate all-ceramic restorations at the chairside without the need for temporaries. Clinical experience had shown that provisionally restored inlay cavities have a significant, negative influence on the integrity of the enamel. In the course of chewing simulations cracks occurred in the oral and vestibular enamel surfaces. In addition, spalling was observed at the enamel margins. Such defects did not occur in cavities which had been treated immediately using chairside CEREC inlays. The conclusion was clear: the immediate treatment of the tooth cavity with chairside inlays and the elimination of the need for a temporary restoration reduce the risk of enamel cracking and marginal spalling. The micromechanical bond between the ceramic inlay and the hard tooth tissue stabilizes the cavity walls. In combination with the adhesive bond, the stabilizing effect of the immediate CEREC restoration on the residual tooth obviously offsets the consequences of wider adhesive gaps, as evidenced in long-term clinical findings.

High-strength CEREC crowns

So far long-term investigations have concentrated almost exclusively on CEREC crowns made of feldspar ceramic materials. At the School of Dentistry, University of Michigan, we decided to investigate the materials suitability of lithium disilicate (LS2, e.max CAD) for full-contour, monolithic crowns. Our aim was to utilize the enhanced flexural strength of LS2 (360-400 MPa) in order to withstand the chewing forces in the premolar and molar regions. The full crown preparation included 2.0 mm functional cusp reduction, 1.5 mm occlusal reduction in the central fissure in combination with rounded shoulders and axial reduction of 1.2 mm. 62 crowns were created for 43 patients on the CEREC 3 system and then placed with the aid of dual-cure luting cement. There was a small degree of sensitivity reported in the first week post-operatively. It was resolved by the third week and there were no reports of sensitivity at the one or two year recall evaluation. After 2 years of clinical service, there were no clinically identified cases of crown fracture or surface chipping Clinical monitoring revealed a positive long-term survival prognosis. Although two years in situ is a relatively short period of time, the survival rates are on a par with those obtained in similar studies of ceramic crowns.

LS2 crowns after two-year recall visit. The immediate treatment of tooth cavity with chairside inlays reduces the risk of enamel cracking and margin spalling.

Emulating Nature

FUNCTION. Fully anatomical single-tooth and bridge restorations have not just fallen from heaven. On the contrary, decades of experience with chairside treatment procedures and the technological quantum leaps of recent years have transformed CEREC into a unique restoration system, says Professor Albert Mehl.

Functional aspects play a crucial role in human anatomy. No two teeth or occlusal surfaces are the same. Each human jaw is unique. Modern dentistry has set itself the goal of reconstructing teeth in such a way that they retain their natural functions.

Over a period of decades academics and researchers have laid the foundations for automated tooth reconstructions. The reliability of their findings has been verified by dental practitioners in numerous clinical studies.

Prof. Dr. Dr. Albert Mehl is a physicist and dentist. He is Director of the Department of Computerized Restorations at Zurich University.

The introduction of CEREC Bluecam technology, which deploys short-wavelength blue light in order to acquire digital impressions, led to a perceptible improvement in precision, depth of field and light sensitivity. At the same time the imaging process was speeded up. This means that the tooth surfaces are mapped with a high degree of detail and sharpness.

The biogeneric modelling function reconstructs a missing tooth by analyzing the morphology of the adjacent teeth and/or the antagonists. The deviations in the occlusal surfaces are less than in the case of wax-ups created by experienced dental technicians. Unlike other occlusal design concepts, the biogeneric tooth model facilitates the metric (i.e. computer-compatible) determination of the missing tooth surface. There is a high degree of probability that the reconstruction will match the patient's individual dentition harmoniously and functionally. In principle the design of the missing tooth can be deduced from any other intact reference tooth in the patient's mouth. However, the greater the distance between the reference tooth and the restoration, the smaller the degree of correlation. The decisive factor is whether the biogeneric software identifies the reference tooth as typical and then generates a suitable design proposal.

These new developments enhance the reliability of the reconstruction proposal and at the same time pave the way to a high degree of automation. ■

Photos: Park, Fasbinder.

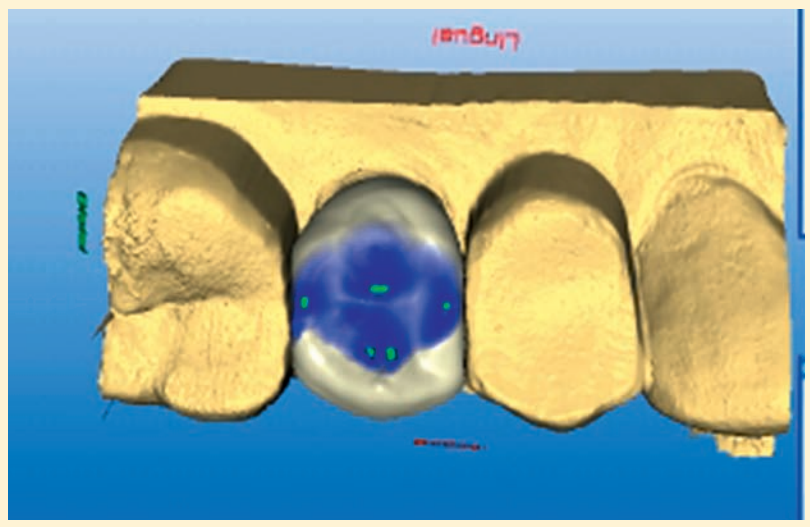
Harmonious and natural movement

BIOGENERIC OCCLUSAL SURFACES. CEREC biogeneric helps creating full-ceramic crowns identical to patients' natural dental morphology. Thus a precise function is guaranteed, is Dr. Jacob G. Park's experience.

The interaction of the maxillary and mandibular teeth, precise function and natural, harmonious movements during the occlusal phase are crucially important for the natural reconstruction of tooth surfaces. This requires a deep understanding of the biomechanical principles of natural dental morphology and its interaction with the entire masticatory apparatus. During the human life span the natural dental morphology is subject to constant change due to abrasion (food-tooth contact) and attrition (tooth-tooth contact). Mechanical stress causes wear to the tooth surfaces. Over time, the crown contours adapt themselves to movement patterns. On the basis of relative cusp and fissure positions it is possible to deduce the principal directions of motion. The fissures and depressions between the cusps describe the paths for antagonistic cusps. Due to the interaction of the antagonists, individual wear patterns emerge on the cusp tips and flanks.

Jacob G. Park, DDS, runs a dental practice in San Antonio, Texas. The experienced CEREC user is also Clinical Professor in the Department of Restorative Dentistry at the Health Science Center in Texas.

In the field of prosthetic rehabilitation the dentist needs occlusal data in order to restore an existing system. For the purpose of computer-aided restorations it was necessary to set up dental databases containing morphological information derived from standardized prosthetic teeth. These databases did not provide access to individual, patent-specific tooth morphologies so extensive milling-in procedures are often required when the restoration is finally placed.



Biogeneric occlusal surface reconstruction.

Biogenerics is based on natural principles

The biogeneric CEREC software V3.80 uses patient-specific biogeneric data to construct occlusal surfaces based on natural models. I was very interested in the advanced technique, as I fabricate approx. 900 CEREC restorations per year. So far I have relied on the design technique based on the detection of the residual tooth tissue for inlays, onlays and partial crowns. With the aid of the biogeneric software, I have meanwhile created and placed approx. 90 crown restorations. The dental database is no longer necessary. The proposals for the occlusal surfaces consistently match the anatomy of the antagonists. The crown designs take account of juvenile as well as abraded tooth morphologies. The functional interrelationships of the cusps and fossae result in harmonious and natural movement. The natural occlusal surfaces require virtually no milling-in. Simple polishing is sufficient to remove any premature contacts. In my opinion the biogeneric crown is a major improvement on the way to achieving an accurate occlusion. ■

Technically always one step ahead

INLAB. Flexible and in tune with customer requirements – key criteria for large-sized dental labs like the one James Glidewell runs. To create all-ceramic restorations, he uses the inLab system. To enhance communication between the dentist and the lab, James Glidewell uses CEREC Connect*.

The USA has outstripped Europe in terms of the application of CAD/CAM and all-ceramic materials in conservative and prosthetic dentistry. The reasons can be found in the particular markets involved. In the USA, patients and dentists can agree autonomously on the type of tooth restoration, without any constraints imposed by the health insurance companies. Moreover, ceramic materials offer decisive advantages in terms of aesthetics, biocompatibility and mechanical strength. Zirconium dioxide (ZrO_2) is a high-strength material that is particularly suitable for long-span anterior bridges featuring dentine-coloured frameworks and thin veneers.

James Glidewell, CDT, is the owner and CEO of one of the world's largest dental laboratories with 2,618 employees in branches in different cities and towns.

No chipping

The problem of veneer fractures (chipping) on ZrO_2 frameworks has been frequently discussed in the scientific literature. This problem can be managed if proper allowance is made for the ceramic material during preparation and the crown copings are designed in such a way that they support the cusps. It has proved to be advantageous when the virtual framework design is reduced by the software by an amount equivalent to the veneer thickness and then milled in line with the anatomical tooth morphology. To prevent subsequent fractures it is important to comply with the minimum connector dimensions of bridge frameworks. In the Glidewell laboratories any necessary corrections to sintered ZrO_2 frameworks are performed using a spray-cooled handpiece equipped with a micrograin diamond bur. Highly aesthetic CAD/CAM veneers are now available for ZrO_2 crowns and bridges in the anterior and premolar regions. This reduces costs and increases profitability.

Cost-effective production

The materials and the production process offer a variety of benefits. The scanners achieve an outstanding degree of precision. It takes only a few minutes to evaluate the data record and design the restoration. The stack milling process does not require any input of labour. Ceramic materials are the ideal basis for aesthetic fine-tuning. With regard to their physical properties the industrially fabricated blocks display a homogenous particle structure and density. Crowns can be fabricated and shipped within one day of receiving the model.

James Glidewell uses the inLab system in his large dental labs.

To create a patient-specific occlusal surface on crowns, the Glidewell labs use the biogeneric software V3.80. The inLab system can now automatically integrate functional characteristics into monolithic crowns. Milling-in requires much less time and effort. In many cases simple polishing using a diamond paste is sufficient to eliminate premature contacts.

On the way to impression-free dentistry

Various factors can compromise the final outcome when dental technicians use elastomer impressions. These pitfalls are irrelevant in the case of digital impressions. Preparation margins are clearly defined. With the aid of the CEREC Connect software the dentist can transmit virtual quadrants, shade samples und facial photographs electronically to dental labs. This new collaborative model will enhance communication between dentists and dental technicians. Although still at an early stage of development in the USA, impression-free dentistry and the electronic transmission of model data will experience massive growth. These new systems are flexible and productive. At present the Glidewell laboratories receive approx. 400 data records every month via the CEREC Connect web portal. We will significantly expand this service – so that we always stay one step ahead.

**CEREC Connect is not available in all countries.* ■

1,174 miles to the dental lab

CEREC CONNECT. Local boundaries are no more. CEREC Connect helps to easily diminuish great distances. The system enables Mike Skramstad, DDS, and Tom Nieting, CDT, to collaborate.

Conventional intraoral impressions are error-prone due to the elastomer compound used for taking the impressions. Intraoral scans, however, replace the elastomer impression compound. CEREC AC uses short-wavelength blue light to digitally measure the patient's oral cavity. On the basis of this data the dentist can create a restoration using the CEREC AC software. With the aid of the CEREC Connect software the dentist can send the digital model and the preparation to a dental laboratory for further processing involving new and conventional methods.

Michael Skramstad, DDS in Minnesota, collaborates with Tom Nieting, CDT, by using the CEREC Connect software. Tom Nieting operates a dental lab ("Dentatrust") located 1,174 miles away in Charlotte, NC.

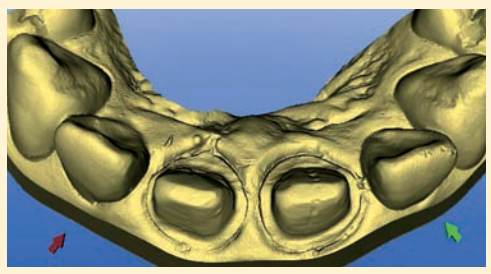
As soon as Skramstad has displayed the quadrant scan on his computer monitor he marks the preparation margin on the digital model. He also scans the opposing jaw. A buccal image is acquired of the patient's habitual terminal occlusion. Via the Internet, Skramstad transmits the data for the permanent restoration to Dentatrust, together with details of the tooth shade, ceramic material, anatomy and function. After the data has been downloaded by the dental laboratory, the dentist and the dental technician generally consult with each other in order to specify the wall thicknesses, occlusal surface design, the contact points and characterization.

A plastic sawcut model ordered at Sirona's infiniDent production centre serves as the basis for creating the restoration. The models feature a software-generated static articulation. The fine-tuning of the veneered restoration is performed with the aid of an average articulator.

Skramstad and Nieting have so far created 20 single-tooth crowns and 15 bridges via CEREC Connect. All these CEREC Connect restorations have successfully undergone their "baptism of fire" – i.e. the try-in in the patient's mouth. Michael Skramstad is very impressed by the fit of the restorations, as well as the functionality of the occlusal surfaces. Very little reworking is required during final placement. He is an adherent of the CEREC chairside procedure for inlays and onlays and will continue to offer this convenient treatment option to his patients. In the case of bridges and aesthetically challenging anterior bridges, however, he now relies exclusively on CEREC Connect to collaborate with specialist Tom Nieting.

Skramstad sees development potential for CEREC Connect in the area of long-span bridges. He also would like to send intraoral scans, created in the correlation mode, to the dental lab in order to facilitate functional wax-ups. This would simplify the design of highly aesthetic anterior restorations. ■

Prepared crown stumps with build-up fillings.



Virtual model composed of several intraoral scans (screenshot).

Monolithic anterior crowns milled out of lithium disilicate on SLA model made of acrylic resin

CBCT and CAD/CAM – a perfect partnership

X-Ray. Modern CBCT technique provides three-dimensional images. This enhances the reliability of the dentist's diagnosis, says Dr. Andreas Bindl from Zurich.

Sophisticated radiographic diagnostics have proven invaluable in every area of dentistry. While conventional panorama imaging (OPG) produces a high resolution slice image, all of the slices generated in one scan are superimposed. However, with computer tomography (CT) it is possible to use reconstruction alogorithms to generate two-dimensional, single slice images. CBCT, which offers three-dimensional imaging, marks another advance as differential radiographic diagnostics offers further benefits. Based on the principle of cone beam geometry, CBCT makes it possible to progress from the generation of images of one or several individual slices to the reconstruction of a specific part of the anatomy. Thus, in one single rotation, 200 image slices measuring 15 x 15 x 15 cm can be collected in 14 seconds (GALILEOS). However, the CBCT can also produce panorama images or Transversal Slice Acquisitions (TSA). Compared to OPG images, the CBCT images are more precise as they provide images with high geometric fidelity.

PD Dr. Andreas Bindl is a registered dental practitioner and lectures at the Centre for Oral and Maxillofacial Medicine at Zurich University.

Due to the use of an image intensifying system the patient radiation dose is much lower than would be the case with CT. Two and three dimensional images can be extracted from the original image volume. 3D imaging produces slices of the three axial, saggital and coronal views (the three main orthogonal planes). The combination of CBCT and CAD/CAM data significantly simplifies the planning of implants and subsequent prosthetic work. Three-dimensional visualization greatly enhances the reliability of the findings and diagnosis, as well as pre-op planning and surgery. This represents the future of dentistry and orthodontics.

Photos: Glidewell, Skramstad.

Safety-first implant therapy

IMPLANT-BASED PROSTHETICS. The integration of GALILEOS and CEREC enhances the safety and precision of implant therapy. Two US-based dentists – Neal S. Patel, DDS, from Powell, OH, and Jay B. Reznick, MD, MDM, from Tarzana, CA – report on their experience with integrated implant planning.

Cone beam computerized tomography (CBCT) systems number among the most advanced imaging devices that are currently available on the market. The insight into the third dimension simplifies diagnostic procedures, enhances treatment safety, and reduces radiation doses for patients. In addition, there are convincing forensic arguments in favour of CBCT. With the aid of thee-dimensional CBCT images users can interpret the clinical situation with much greater accuracy. They can evaluate the optimum drilling angles for various perspectives (saggital, coronal, axial) and generate transversal slices and panoramic images. Compared with conventional CTs, CBCT systems are less sensitive to metal artefacts. Thanks to the availability of three-dimensional imaging, dentists are in a better position to assess the risks of treating certain cases 'in-house'. In addition, CBCT users can create digital networks with their colleagues and advertise their services to referring dentists.

Neal S. Patel, DDS, operates a dental practice in Powell, Ohio. He is a CEREC user as well as an Advanced Trainer for the GALILEOS CBCT system.

An important reason for purchasing a CBCT system is the time and effort involved in referring patients to external radiologists – both for the patient and the dentist. In some cases patients do not return after being referred. In addition, the diagnostic results are sometimes delayed, and the reports are not directly assigned to the X-ray images. Referrals to external radiologists tend to disrupt the patient counselling process. Experience has shown that patients rate the expertise of a dental practice more highly when all services come from a single source and when the dentist is directly involved in the diagnosis of the X-rays. The higher costs of a CBCT image compared with a conventional panoramic X-ray can be easily justified by referring to the clear diagnostic and therapeutic benefits. A convincing argument is that a CBCT contains 300 MB of information – as compared with only 5 MB in the case of a digital panoramic X-ray.

Implant planning using GALILEOS and CEREC reduces the number of appointments. Less laboratory work is required. In most cases it is not necessary to produce waxed-up prosthetic reconstructions. The combination of digital imaging and computer-aided design generates all the necessary information for the dental lab, thus ensuring transparent working procedures. The decisive factor is that the integration of GALILEOS and CEREC streamlines the dentist's workflow and leads to reliable clinical results.

Enhanced clinical reliability…

A very useful feature of the GALILEOS system is the built-in implant database, which contains the dimensional data of various commonly used endosseous posts (Astra, Straumann, 3i, Bicon, BioHorizons and Z-Look). By combining the GALILEOS image, the clinical CEREC scan and the virtual superstructure design the user can dispense with a prosthetic wax-up model. Instead, a template is used that is easily fixated in the patient's mouth. The prosthetic planning is carried out fully digitally by using the CEREC software. Thereafter, the prosthetic planning data is imported into the CBCT scan, eliminating both the need to create a X-ray template and to form a barium-sulphate prosthetic model. This leads to more precise results. Moreover, since no barium-sulphate is used, the CBCT image does not lack in quality. The positions of the endosseous drill holes are determined by means of plastic surgery guides (SICAT/Sirona). Minimally invasive flapless implantation eliminates the need for the elevation of the mucoperiosteal flap. This not only minimizes surgical trauma, but also permits the immediate placement of the restoration on the implant.

…. and less laboratory work

The ability to import the CEREC data into the CBCT image significantly streamlines the implant planning workflow. The interaction between GALILEOS and CEREC means that only two appointments are required, at an interval of five to seven days. Thanks to the surgery guide, the invasive surgical insertion of the endosseous post takes only 15 minutes – resulting in greater precision and reduced stress. Using the conventional method (i.e. without a CBCT scan and surgery guide) each implant requires up to 45 minutes and is accompanied by greater risks.

Jay B. Reznick, MD, DMD, operates a dental practice in Tarzana, near Los Angeles. He specializes in implantology as well as tooth and skin transplants.

So far custom-made angled abutments with individual emergence profiles have often been required in order to compensate for divergences in the insertion angles between the implants and the superstructures. Thanks to the integrated implant planning process, it is now possible to deploy competitively priced, industrially prefabricated abutments. The precise planning of the angulation in the CBCT image and the guided drilling process ensure a better fit between the endosseous post and the superstructure. If required, specially shaped abutments can be created out of zirconium oxide using the inLab system. As a rule the implants are luted directly to single-tooth implants. To protect the gingiva overpressed luting residues must be carefully removed. Following the attachment of the abutment and the closure of the screw access, it is advisable to place a retraction cord in order to expose the tissue and the abutment margin.

The abutment is then conditioned with titanium powder in preparation for acquiring the intraoral impression using the CEREC AC and designing the final implant crown. The crown is then automatically milled to anatomical dimensions out of a lithium disilicate block (e.max CAD). The try-in should be performed prior to crystallization. This is followed by crystallization, polishing/glazing and luting to the abutment. If stringent aesthetic requirements have to be fulfilled (e.g. in the anterior region) the LS2 crown can be cut back and then individually veneered.

SICAT surgical guide.

Inserted zirconium oxide abutments.

Implants with superstructures in situ.

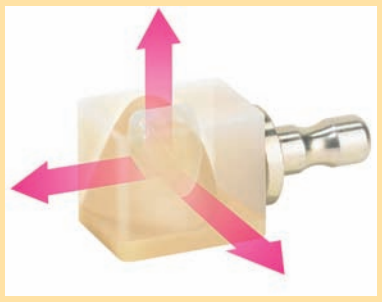
Conclusions

To a significant extent GALILEOS and CEREC simplify implant planning and superstructure fabrication. The clinical outcomes are predictable. Compared with conventional methods, treatment is much faster. The 3D images and the virtual prosthetic proposal play a valuable role in patient counselling. There is an increased likelihood that the patient will accept the plausibility of the proposed treatment and give his or her consent more quickly. ■

Photos: Patel, Reznick.

Realistic ceramic restorations

VITA. RealLife blocks with a 3D structure specially adapted for anterior restorations are developed.



VITABLOCS RealLife: The curved layers reproduce the gradation of shade that is naturally present between the dentin and the edge areas.

Since June 2010, a new 3D ceramic block has been available for the efficient fabrication of exceptionally natural-looking anterior restorations. Vita Zahnfabrik has designed the innovative VITABLOCS RealLife for CEREC / inLab MC XL specifically for restorations using highly aesthetic veneers as well as partial and full crowns in the anterior area. Particularly special about RealLife is its unique three-dimensional block structure with a dentin core and enamel shell that allows practitioners to replicate the natural curved gradation of shade between the neck and edge areas.

Combined with modern CAD/CAM technology, VITABLOCS RealLife facilitate computer-aided fabrication of restorations with a natural play of colors. Individually adapted to match the existing dental substance, RealLife restorations can be provided with a greater proportion of dentin or enamel with just a few mouse clicks.

To process VITABLOCS RealLife, the user requires version 3.80 of the construction software (available since June 2010) and the CEREC/inLab MC XL system. Following block selection, the software automatically positions the construction at the dentin-enamel junction of the block. As the restoration can be freely positioned in all three spatial planes and in terms of the required angle, this system offers maximum creative scope. The user can thus adapt the planned restoration exactly in line with the nuances in shade of the remaining natural dental substance.

As a result, the processing step of characterization using staining technique or customization using layering technique is often no longer required.

The blocks are available in size RL-14/14 (14 x 14 x 18 mm). In accordance with the VITA SYSTEM 3D MASTER shade standard, the range of shades includes 1M2C, 2M2C and 3M2C.

According to the manufacturer, the range of shades will be extended to include 0M1C, 1M1C and 2M1C from 2011.

RealLife: a natural play of colors guaranteed

ANTERIOR AESTHETICS. With the new VITABLOCS RealLife and V3.80 of the CEREC 3D software, the Swiss dentist Dr. Alessandro Devigus is delivering superior anterior aesthetics in just a single session.

CAD/CAM technology is employed in restorative dentistry to allow exceptional quality restorations that are also aesthetically pleasing to be fabricated quickly and inexpensively using an automated production process. Tooth-colored ceramics are vastly superior to metal restorations in terms of their aesthetic characteristics and have proven their worth in the treatment of posterior teeth. Nevertheless, reproducing the gradation of shade naturally present in anterior teeth was, up until now, a particular challenge. In the case of monochromatic ceramic blocks in particular, a natural play of colors could often only be achieved using staining or layering techniques. Dentists therefore had to schedule more time in order to achieve a suitably aesthetic result.

RealLife 3D block structure

With VITABLOCS RealLife, VITA Zahnfabrik (Bad Säckingen, Germany) is setting new standards in anterior aesthetics. The ceramic material with its unique 3D block structure is comprised of a dentin-colored, parabolic-shaped core with a shell similar to natural tooth enamel. With the new construction software CEREC 3D V3.80, a few clicks in the milling preview are all that's required in order to customize the proportion of enamel and dentin in the anterior tooth restoration. The result is outstanding. Characterization using staining techniques is no longer required.

Case study: anterior tooth restoration

A 17 year-old patient suffered trauma damage to tooth 21 as the result of an accident. Endodontic treatment was carried out, with the tooth subsequently subject to orthodontic extrusion. Five years later, the patient clearly wanted the tooth to be restored. A gingivectomy was initially performed in order to correct the contours of the gingival margins, followed by core build-up. Tooth 11, which was intact, was selected as the virtual modeling template.

Dr. Alessandro Devigus, dentist in practice in Bülach/Switzerland, is President of the Swiss Association for Computer-Aided Dental Medicine (SGcZ).

For this reason, the biogeneric reference design technique was selected for the CEREC restoration. This technique allows the user to reproduce any intact tooth surface on a prepared area. Using the positioning, rotation, scaling and editing tools, the replicated tooth surface can be precisely positioned over the prepared area and adjusted accordingly. The advantages of this technology are that it ensures exact reproduction of the optical characteristics of the existing dentition and generally only requires minimum intraoral adjustment.

Following preparation and drainage, the working field was matted using titanium dioxide powder and digitalized using the CEREC Bluecam intraoral camera. The picture of the prepared area was used as a reference image. The adjacent tooth to be replicated was directly included in the imaging process.

If the tooth is further away, an additional optical impression is taken of the tooth to be replicated using the occlusion icon. The 3D view of the prepared area was then calculated by the software. Afterwards the virtual model was trimmed and the preparation margin defined. The copy line was then manually drawn, the surface replicated onto the prepared area, and final adjustment performed using the tools provided.

Maximum creative scope thanks to flexible positioning

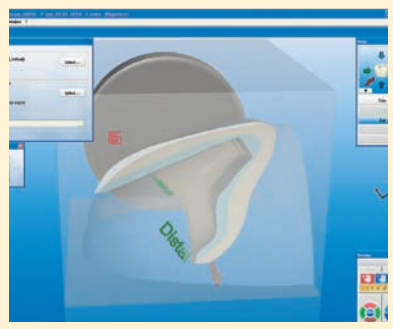
In the milling preview, the position of the restoration within the block can be adjusted to individual requirements once VITABLOCS RealLife has been selected. In this way, the user can adapt the planned restoration exactly in line with the nuances in shade of the adjacent natural dentition. To allow the treating dentist maximum creative scope, the position of the restoration can be freely selected in all three spatial planes and in terms of the required angle. Once milling had been performed, the crown was glazed in this case using VITA AKZENT glaze spray. The restoration was cemented into position using Multilink luting composite from Ivoclar Vivadent.

Result: maximum aesthetics with minimum effort

Using VITABLOCS RealLife we were able to achieve a superior aesthetic result in just a single session, by quickly completing just a few steps. Although the restoration was not stained or customized, the patient was very happy with the result.

This was possible thanks to the 3D block structure of the new CAD/CAM material: similar to natural dentition, the proportion of enamel in VITABLOCS RealLife decreases in the labial-oral direction, while the proportion of dentin increases. This enables the most delicate natural nuances in shade to be replicated at virtually the touch of a button. ■

As a result of an accident, tooth 21 was subject to orthodontic extrusion.



The software automatically positions the restoration at the dentin-enamel junction within the block.

Thanks to VITABLOCS RealLIfe, a superior aesthetic result was achieved in one session.

CEREC 3D V 3.80: Biogenerics – and more besides

INNOVATIVE SOFTWARE. The biogeneric modelling function for occlusal surfaces is just one of several innovations contained in the upgrade.

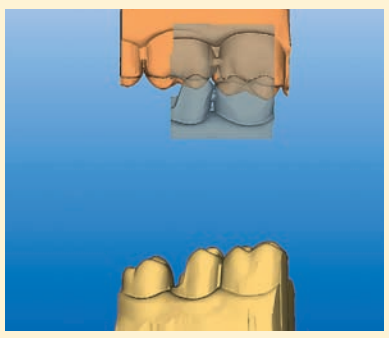
Faster treatment, enhanced convenience, an extended range of applications – these are the defining features of Version 3.80, which was launched this summer.

Christopher Goodson, is Software Product Manager for Sirona in Bensheim.

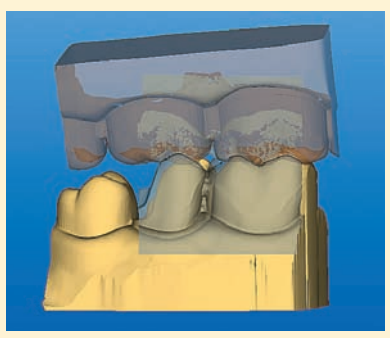
Buccal bite registration speeds up the CEREC treatment procedure. In order to correlate the occlusal surfaces of the preparation and the antagonist the patient no longer has to bite on a silicone compound. With the aid of the CEREC Bluecam the dentist can now acquire a buccal image of the closed occlusion. Following this, the buccal image is superimposed on the antagonist by dragging the buccal image. After correlation has been completed the contact strength can be checked by clicking on the "Toggle Contacts" button.

The new software version now supports the scanning of silicone impressions via the CEREC Bluecam camera. This function is activated by clicking on the "Change View" icon at the side of the preparation image catalogue. In the 3D preview the model is shown in yellow, and the impression in green, thus helping the dentist working on side teeth and subgingival preparations by making these areas visible.

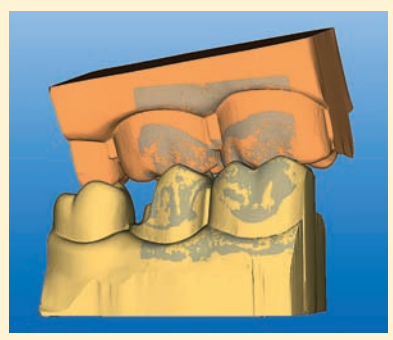
Until now, only the dental lab could make bridges using plaster models. The new CEREC 3D software version 3.80 allows dentists to fabricate bridges with up to four units directly at the chairside. Four unit bridges for temporaries can also be created chairside. In the meantime the data can be transmitted via CEREC Connect to the dental laboratory where the restoration is created whithout using a model thanks to the inLab system using the 3D software version 3.80 and multilayer technique. The multilayer technique enables the dental technician to employ the same biogeneric occlusal surface the dentist uses for the temporary bridge. ■



The buccal image is superimposed on the antagonist.



Then the buccal image is superimposed on the preparation.



The correlation has been successfully completed.

Photos: VITA, Devigus, Sirona.

The supreme test

ANTERIOR AESTHETICS. Silicate ceramics meet the patients high standards in terms of aesthetic and functional reconstruction. James Klim, Director of the CAD-Star CEREC Learning Center, talks about his experience in anterior aesthetics.

Patients have an acute awareness that correct and aesthetic dentition stimulates a feeling of well-being and enhances their social standing. For this reason dentists are confronted with great expectations on the part of patients when performing anterior restorations.

Any reconstruction requires to first explore the patient's wishes in detail, thus eliminating subsequent misunderstandings, disappointments and differences of opinion. I usually create a mock-up in order to define the final form of the restoration. This allows the patient to evaluate the design proposal. Modern silicate ceramics already meet high standards in terms of chroma, translucency and integration into the existing dentition. However, characterization steps may still be necessary to create a natural-looking effect. This necessitates careful shade-taking, also including the dentine core as well as the incisal and cervical surfaces. I use self-produced, 1 mm thick ceramic platelets in various tooth shades and opacities. This allows me to determine the degree of transparency on the tooth surface. To achieve the desired result I often mill two or three restorations with different shades and transparencies. In the case of discoloured dentine I recommend the bleaching of the residual tooth and the extension of the ceramic wall thickness.

For anterior veneers and crowns I prefer silicate ceramics (VITA TriLuxe, Empress CAD Multi). These materials imitate the enamel-dentine shade gradation of natural teeth and display opalescent properties at the incisal edge. Lithium disilicate (Ivoclar e.max CAD) is used for premolar crowns in order to compensate for the higher chewing forces. Thanks to the higher flexural strength of this material I can adopt a substance-conserving preparation approach.

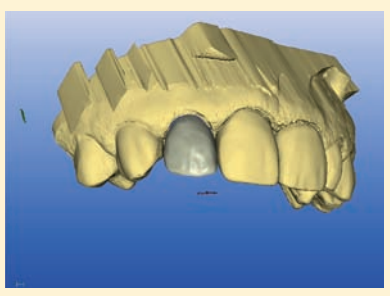
James Klim, DDS, runs a private practice in Santa Rosa, CA. He is founder and Director of the CAD-Star CEREC Learning Center.

After being polished, monolithic crowns obtain a smooth, aesthetic surface finish with good refractive properties. Externally applied shading products improve the cervical adaptation to the dentine. Polychromatic effects, special characterizations (e.g. mamelons) and texturing can be achieved via the cutback method.

CEREC veneers offer fascinating possibilities and are indispensable in terms of aesthetic and functional criteria. Good results can be expected in the case of defective fillings, positional anomalies, diastemata, morphological corrections, discoloration/shade correction, repairs to veneered prosthetic devices and the rehabilitation of palatinal canine guidance..

Treatment has become even more effective following the introduction of the CEREC AC acquisition unit and the new biogeneric software V3.80, augmented by the requirement-oriented selection of materials for temporary and permanent restorations. CEREC passes the supreme test – the aesthetic restoration of the anterior teeth – with flying colours. But although aesthetic results are an overriding concern, they are doomed to failure without proper functions. For this reason it is necessary to diagnose the bite situation, occlusion, wear facets, stress-induced abrasions as well as the function of the TMJ in order to detect any defects or anomalies. ■

Damaged tooth 12 before preparation.



Virtual model with anterior proposal.

Final anterior result.

Visualization reassures patients

GALILEOS. Patients accept the proposed treatment plan sooner if dentists show them 3D simulations of their treatment. That's what Tarun Agarwal, DDS, realized in his practise in Raleigh, North Carolina.

The evaluation of the osseous structure as an implant site and the ability to accurately pinpoint the alveolar nerve are key diagnostically significant findings of radiological preparation for implant procedures. The 3D data generated using CBCT (GALILEOS) provide significantly more detail than 2D imagery.

Tarun Agarwal, DDS, has been practising privately since 1999 in Raleigh, North Carolina.

I use CBCT in endodontic examinations prior to root canal treatment and in follow-up checks of root canal fillings. The image quality enables a clear evaluation of the treatment outcome, especially in the apex radicis.

To ensure the correct placement of the drill for implants on the alveolar bone I use a surgical guide. Possessing more exact knowledge of the clinical and prosthetic status of patients substantially increases the number of risk-free implantations. Few patients need referral to a surgical practice.

For general dental practices not specialized in implantology the economic viability of employing GALILEOS and CEREC for prosthetic-based implant procedures depends on increasing the number of patients who opt for this method. Patients who were shown 3-D simulations of their treatment could draw the analogy between crowns and implants and their natural teeth more easily and accepted the proposed treatment plan sooner.

I also use the CEREC data set to fabricate the provisional prosthetic for the period required for enossal healing and the acceptance of the peri-implantal soft tissue. Practitioners like the idea of also being able to fabricate the drilling template chairside. In situ planning and component fabrication, including the fabrication of abutments with emergence profile, as well as the milling of fully anatomical, framework-free crowns made of lithium disilicate are a prerequisite to chairside implant and prosthetics procedures in the dental practice – perhaps even in one sitting. I favour post-supported single tooth implants instead of multiple tooth bridges, which are supported by just a few posts and present a greater risk of overloading the osseal base of the implant. Screwing the abutment avoids the problem of cement residue in the sulcus. Only where there is not enough space for this approach is the adhesive fixture of abutment considered an option. ■

Photos: Klim, Agarwal.

CEREC & GALILEOS collaborate in Tokyo

PRACTICE PORTRAIT. The reputation of Dr. Yukio Kusama's dental practice in Tokyo rests on two main pillars: all-ceramic materials and aesthetics. The practice team deploys tried-and-tested technology (both chairside and labside) in order to offer patients the highest degree of comfort in every situation.

Due to the special factors governing the Japanese healthcare system, all-ceramic restorations and dental CAD/CAM systems became established a decade later than was the case in Europe. Sirona Dental Systems K.K., Japan, was founded in 2004 in response to the growing interest in all-ceramic restorations and rational CAD/CAM processes in East Asia.

In 2005 the Tokyo-based Dr. Yukio Kusama was one of the first Japanese dentists to adopt the CEREC procedure for conservative dental treatment. Inlays, onlays, partial crowns and crowns are fabricated directly at the chairside using silicate ceramic materials. To extend his spectrum of prosthodontic services Dr. Kusama recently acquired the Sirona inLab system for his in-house dental laboratory, which is managed by his son. Large-sized restorations are machined on an inLab MC XL system installed at the dental lab of the Nishishinjuku Dental Clinic in the neighbouring district of Nakano. In 2009, in his role as implantologist, Dr. Kusama decided to install the GALILEOS conebeam computerized tomography system as a basis for integrated diagnosis, implant planning and surgical preparation. His team meanwhile consists of four dentists, seven assistants, five dental hygienists and three dental technicians.

More patients – thanks to CEREC

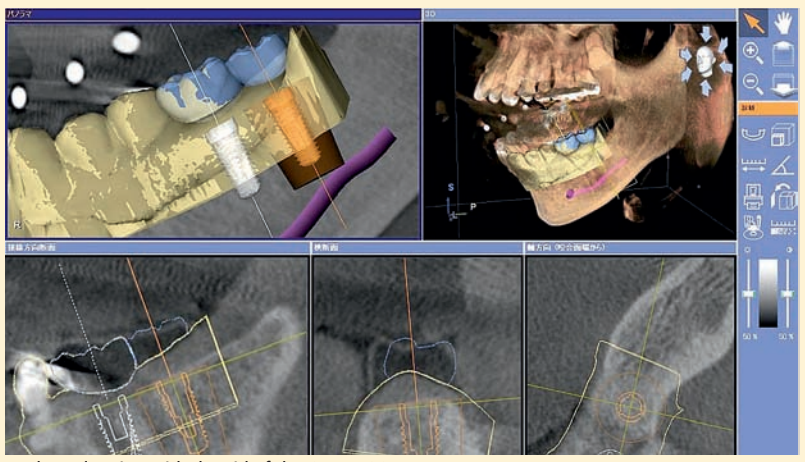
Dr. Kusama's treatment strategy centres on detailed diagnostics, backed up by a professional preventive care program. This ensures the long-term clinical survival of the treated teeth. Video clips shown in the waiting room inform patients about state-of-the-art restoration techniques and the CEREC procedure. The dental assistants and hygienists, who have themselves undergone CEREC therapy, are available to advise patients. This approach has proved to be highly successful: the majority of the patients now opt for metal-free restorations. Every month the dentists place between 100 and 200 CEREC restorations. The key benefits of the CEREC procedure – i.e. digital impression-taking, no need for temporary restorations, single-visit treatment, aesthetic ceramic materials, the growing acceptance of CAD/CAM technology – have reinforced patient loyalty and generated positive recommendations. As a result Dr. Kusama's practice has succeeded in extending its catchment area.

The decision to adopt a chairside or labside treatment approach depends on the time and effort required to produce the restoration. According to Kusama, CAD/CAM technology delivers clear economic benefits, both in the dental practice and the dental lab. The CEREC and inLab systems eliminate numerous conventional processing steps – and deliver excellent results.

The introduction of the CEREC system generated perceptible economic benefits for Dr. Yukio Kusama's dental practice. His team now comprises four dentists, seven assistants, five dental hygienists and three dental technicians.

Precise diagnostics and planning via CBCT

With the purchase of the GALILEOS CBCT system in 2009, Dr. Kusama fulfilled a long-standing wish – i.e. enhanced reliability and diagnostic accuracy in the area of implant planning. The three-dimensional X-ray images are extremely precise. CBCT simplifies the visualization and measurement of the initial bone situation, including nerve exit points in the foramen mentale. By making precisely determined depth markings on the surgical bur and the surgical guide the dentist can eliminate the risk of excessively deep preparations in the cancellous tissue, following the penetration of the cortical bone. The surgical guides are supplied by SICAT/Sirona in Germany. According to Dr. Kusama, the key criteria for selecting the GALILEOS system were as follows: prosthetic-based treatment planning; the possibility of creating surgical guides for implant insertion purposes; and the system's low-dose 3D imaging capabilities. ■



Implant planning with the aid of the GALILEOS system.

Zirconium oxide mesostructure and the finished restoration in situ.

COMING SOON

14. - 16.10.2010 BDTA Dental Showcase, Excel, London, UK
14. - 17.10.2010 ADA, New York, USA
29. - 30.10.2010 SAACD CEREC Masters Congress, Polokwane, South Africa
05. - 06.11.2010 Dental Facial Cosmetic Conference, Dubai, UAE
06. - 11.11.2010 Kinki Hokuriku Dental Show, Osaka, Japan
09. - 11.11.2010 Dental Expo, St Petersburg, Russia
18. - 20.11.2010 Swedental, Gothenburg, Sweden
26.11. - 01.12.2010 GNYDM, New York, USA
15. - 16.12.2010 International Dental Meeting RIDM, Riyadh, Saudi Arabia

Photos: Kusama.